

UNCLASSIFIED

Defense Technical Information Center
Compilation Part Notice

ADP012347

TITLE: Effects-based Coalition Operations: Belief, Framing and Mechanism

DISTRIBUTION: Approved for public release, distribution unlimited
Availability: Hard copy only.

This paper is part of the following report:

TITLE: KSCO 2002: Second International Conference on Knowledge Systems for Coalition Operations

To order the complete compilation report, use: ADA402533

The component part is provided here to allow users access to individually authored sections of proceedings, annals, symposia, etc. However, the component should be considered within the context of the overall compilation report and not as a stand-alone technical report.

The following component part numbers comprise the compilation report:

ADP012330 thru ADP012354

UNCLASSIFIED

Effects-based Coalition Operations: Belief, Framing and Mechanism

Maris McCrabb

DMM Ventures, Inc.
107 Elise Place, Yorktown, VA USA 23693
buster@dmmventures.com

Abstract. Coalition operations over the past decade exhibit a propensity towards collegial decision-making even in the presence of formal, normally hierarchical, decision-making apparatus. Meanwhile, the US military, especially the US Air Force, is adopting effects-based operations (EBO) as a method of planning, executing, and assessing military operations that achieves desired effects that attain strategic objectives. EBO forces decision makers to look at outcomes and their explanations more so than on actions taken. Hence, an EBO approach significantly affects decision-making. Both these requirements, collegial decision making and EBO, affect supporting knowledge systems. This paper explores all these implications. Following a short explanation of the problem, the second section describes EBO. The third section contrasts collegial decision-making models with traditional hierarchical decision-making models. This draws largely from work done for the US Air Force Research Laboratory Human Effectiveness Directorate (AFRL/HE). Section 4 presents research on a situation-aware, recognition-primed, variable risk-propensity model of collegial decision-making based in an EBO context. Section 5 discusses the implications of that model and EBO on knowledge base design requirements. Section 6 concludes the paper and offers some areas for future research.

1 Section 1 Introduction

The essence of military command is allocating—deciding—scarce resources to attain desired goals. Linking the use of resources—actions—and the outcomes those actions obtain is the domain of strategy. There are many methods of developing strategy. Each ultimately revolves around how the decision-maker believes the actions taken will achieve the desired outcome. This causal explanation is called mechanism. Older strategies focused on the actions taken. Current approaches tend to focus solely on outcomes with little concern on understanding how those outcomes arose from the actions. Effects-based operations (EBO) focuses on causal explanations: why will (i.e., planning) or why did (i.e., post-execution) the actions planned (taken) result in the desired effects? This description suggests two critical elements. One is assessment: how can a decision-maker understand the causal mechanisms. The other is decision-making. What impact does an EBO method have on decision-making? Compounding this question is coalition operations where decisions are more framed through collegial processes rather than hierarchical processes. It is the issues of EBO, decision-making, and coalition operations that concern this research note.

2 Section 2 Effects-based Operations (EBO)

2.1 Description.

Effects-based operations (EBO) is an approach—a way of thinking—to planning, executing, and assessing military operations that focuses on the results of military operations—and the explanation of how those results came about—rather than the actions—sorties flown, rounds fired, or tons of relief materials delivered—of military units. (Davis, 2001) It is thinking strategically. (Dixit and Nalebuff, 1991) As such, it spans the gamut of military operations from humanitarian relief to major theatre war. It accounts for lethal and non-lethal applications of force delivered kinetically or via non-kinetic modes. EBO incorporates and expands upon traditional approaches such as targets-based and strategy-to-task. The most significant challenge for EBO is predicting and assessing how physical actions result in behavioural outcomes. Physical should not be confused with merely flying aircraft or dropping bombs.

Pushing keys on a computer keyboard instigating a computer network defence is a physical action. Issuing messages an enemy can “intercept” from a fictitious headquarters, as part of a deception operation is also a physical action. The goal of an effects-based approach is tracing and understanding how those actions affect the attacker or enemy commander’s behaviour. Functions are defined as broad, fundamental, and continuing activities. Processes, or activities, are how work—tasks—is done. For commanders, the most basic activities are planning, executing, and assessing operations. EBO is a method for accomplishing those tasks. This section describes those activities from an effects-based perspective. (McCrabb, 2002)

2.2 Effects-based Planning.

EBO, as with any approach to planning, executing, and assessing military operations, starts with Commander’s Intent. See Figure 1. The provision of end state, purpose, method, and risk begins the process of mission analysis where objectives, desired effects, specified, and implied tasks, constraints and restraints and other needed elements of information start. For example, the method specified in Commander’s Intent may direct an analysis of nonlethal applications such as deception or psychological operations. Likewise, listed restraints on certain types of collateral damage—for instance, damage to electrical power systems—may preclude certain strategy options. The end state lists the set of conditions required to achieve the JFC’s objectives. Purpose provides the rationale for the mission. In simpler terms, the end state gives *what* is to be accomplished. Method gives *how* the end state is to be accomplished. In

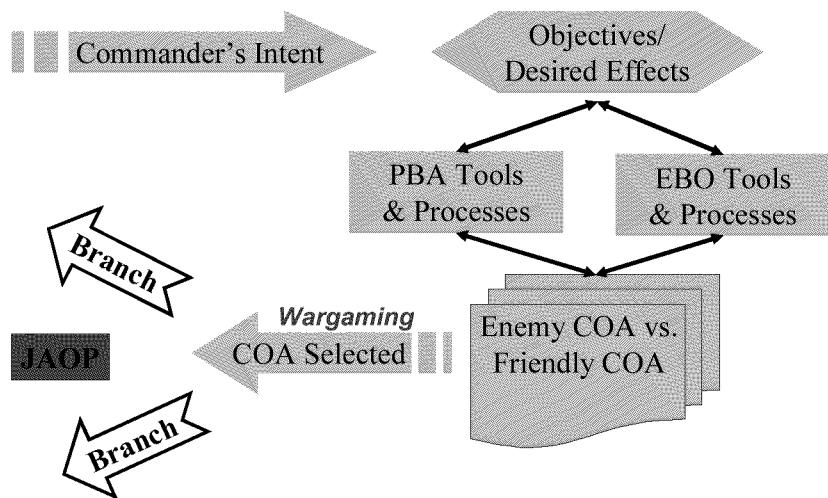


Fig. 1. From Commander’s Intent to JAOP: COA Development

addition, purpose gives *why* the end state is to be accomplished.

Strategy (COA) development. Together, these form the heart of a course-of-action (COA). At the JFC and JFACC level, the COA embodies the commander’s strategy—the art and science of employing resources to accomplish objectives. The COA is the plan of activities the commander envisions that accomplish the objectives and desired effects. Commander’s Intent, strategy, and COA can be used almost interchangeably though COA generally contains the most detail. Besides the *what*, *how*, and *why*, a COA includes *with* (resources), *who*, *where*, and *when*. It also includes mechanisms, sometimes referred to as the second *why* since mechanism explains why an action should result in some specified effect.

Between the method and COA, a complete description of the chosen strategy should be available. See Figure 2. EBO is a method, not a strategy. Attrition is an effect. Paralysis is an effect.

Targeting: COG/TS analysis. Targeting is the analysis of the situation in relation to the commander's intent and available resources in order to discover vulnerabilities that, if exploited, attain the commander's intent. Normally, this analysis starts with centre-of-gravity (COG) analysis and proceeds

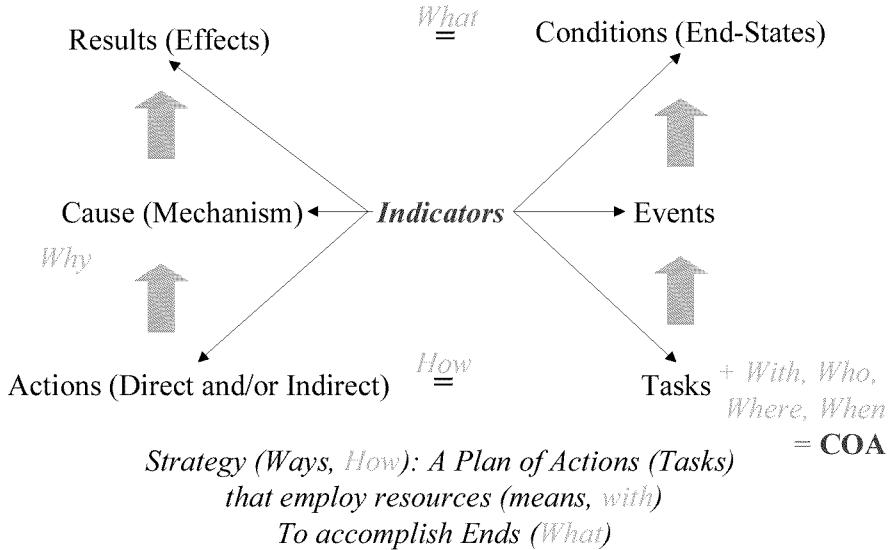


Fig. 2. COA Development: EBO and Operational Art

through target systems analysis (TSA) and concludes with identification of desired mean of impact, if that is appropriate. A COG is those characteristics found in the situation, for example, in an enemy, from which the adversary or friendly elements derive their will or capabilities. It is the point or points against which all our energies should be directed in order to exploit an enemy's COG or to defend our own. A COG may or may not be directly accessible and may change within the course of a campaign or operations. COG exists at all levels of warfare. The COG/TS analysis provides the objects for the commander's desired effects. For example, a communication link within an Integrated Air Defence System may be the object for disruption in order to gain the desired effect of freedom of air action over an enemy. An Information Warfare attack against one or several of those links might be the actions that would trigger a mechanism, e.g., inability to pass data, which results in attaining the desired effect of "disrupted communication."

DAEO generation. The planning process takes commander's intent and turns it into orders executing units carry out. This mission data today is found in an Air Tasking Order. In the near future, it might be available in a Dynamic Air/Space Execution Order (DAEO). In order to counter emerging threats or exploit emerging opportunities, commanders require the means of reacting very quickly. This argues against a batch process and towards a more continuous process. Air and space power is often falsely charged with being unresponsive due to the length of the ATO cycle. Experience shows this not to be the case. From World War II and Vietnam War cases where close air support (CAS) missions were employed within minutes of requests, to the Gulf War's system of "push CAS" where aircraft were constantly on station, often returning with their munitions unexpended, air and space power showed great responsiveness and flexibility. Still, planning processes tend towards batching sorties into one ATO. The DAEO process envisions a largely continuous process where target queues are dynamically executed as they are built. Dynamic does not mean instantaneous. If a desired effect is known minutes, hours, or days in advance, the DAEO can be generated—and refined—as the requirement is known.

2.3 Effects-based Execution

DAEO execution. A key ingredient in the success of the DAEO process is the collaboration between the operational-level tasking organization—normally the Air Operations Centre (AOC)—and the tactical-level execution organization, normally a squadron through a Wing Operations Centre (WOC). This collaboration, which starts during the planning process, continues throughout execution. It is embodied in the concept of centralized command and control and decentralized execution. The AOC maintains track of the status of the plan’s accomplishment of commander’s intent from a theatre-wide and top-down perspective. The WOC maintains track of the status of specific tasks assigned by the AOC from a bottom-up perspective. Since each task likely contributes directly to the attainment of some direct effect and indirectly to the attainment of some cumulative effect, the close collaboration between WOC and AOC is essential.

2.4 Effects-based Assessment

COA assessment. Assessment activities begin well before tasks are executed. During the planning process, assessment requirements are an integral part of the JAOP, COD, and DAEO generation. The second set of assessment activities during planning are those directly related to assessing the likelihood the COA options developed will attain commander’s intent. This assessment process occurs largely through wargaming. The enemy COA are war-gamed against Blue COA options using criteria established by the commander. Normally this includes adequacy, completeness, and feasibility plus other criteria such as probability of friendly losses, time to attain the objectives and desired effects, and collateral damage. The outcome of war games is used by staff to form their recommendation to the commander on which COA option to adopt. Note that often the COA options not adopted become branch plans so the wargame information is retained. Often commanders will modify staff recommendations. Under the

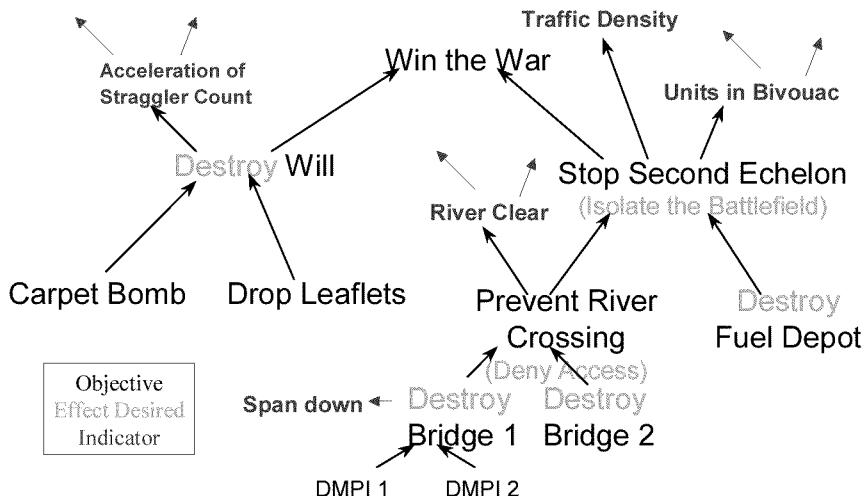


Fig. 3. Indicators Are Crucial For Assessment

DAEO construct, this feedback into the planning process is expected. As the COA is modified from its original form, the assessment process recalculates the probability of attaining commander’s intent as well as the changes in the criteria values. Again, the goal is providing useful information to the commander for their decision-making.

Campaign assessment. The traditional combat assessment process can be viewed as a bottoms-up or vertical process. Effects-based campaign assessment can be viewed as a horizontal process. It is the merging of the two that provides a commander the richer view of operations than previously available. Effects-based assessment starts with indicators. See Figure 3. These are the evidence of effect, mechanism, or action. Combat assessment traditionally focused on effects and actions at the direct,

physical effect level. Campaign assessment builds upon and broadens this to include the indirect, complex, and cumulative behavioural effects. For example, if the operational objective and desired effect is to isolate the second echelon, that cumulative effect is likely to include a mixture of direct, physical effects as well as indirect, behavioural effects. The functional and systemic damage assessments from BDA can provide information on the former—for instance, the status of lines of communications—while the indicators planned for the indirect, behavioural effects and mechanism—such as COMINT reports on enemy movement plans—adds more depth to the analysis on whether the isolation is being achieved.

2.5 Section Summary

This summary of EBO theory described the many and varied decision points commanders face during planning, execution, and assessment of a military operation. The following section delves into decision-making theory.

3 Section 3 Decision Making Models

3.1 Classic Hierarchical Decision Making Models.

This section paves the way towards developing a collegial decision making model that supports effects-based coalition operations. It briefly describes three generic models: the classic rational actor model, an early modification of that model, and the observe-orient-decide-act (OODA) model that has gained wide popularity as a military decision making model. Next, some early attempts to examine collegial decision making situations are described. These efforts focused on the pathologies of decision making that arise from group situations. “Decide by committee” to this day evokes negative images in most people. Despite this, most decision-making does take place among several individuals. Therefore, the last subsection describes the elements in a collegial decision making model that must be accounted for in developing a prescriptive model of collegial decision making.

3.1.1 Rational Actor model

The theory of rational choice in decision-making is one of the oldest portrayals of human behaviour (March, 1994). It is one of the most aspired to approaches to decision-making and one of the most misunderstood. Rational decision-making does not mean “good” decisions always arise. Rather, it is a procedural approach that is consequential, in that actions taken are believed to cause future outcomes, and preferential, in that the decisions made reflect the preferences of the decision maker. The key word here is belief. Later in this paper, the critical role of framing is discussed. That is how the argument is structured. It is the claim of this paper that in a collegial decision making environment, arguments (say, for example, about how a set of actions will lead to some given effects) that are structured around the most common belief schema of the parties involved are most likely to result in the shared understanding of the group. While perhaps intuitive, it must be pointed out that a group that employed a rational choice model is unlikely to reach much of a degree of shared understanding because of the preferential element located within that model. Hence, only to the degree the individuals in a group have shared belief, as common preferences, will a rational choice decision-making model work in a collegial environment. Shared belief is uncommon in coalition operations amongst all members, especially coalitions formed for a single purpose or contingency, or a long-standing coalition when new members arrive.

March points out that, “Some versions of rational choice theory assumes that all decision makers share a common set of (basic) preferences.” (March, 1994: 3) Other elements (and limitations) of the model are that all alternatives are examined, that all decision makers have perfect information about the alternatives (especially consequences), and that there is some objective function used to define the selection criteria. From there, decision-making becomes almost mechanical. Such models are highly adaptable to quantification and mathematical processes.

3.1.2 Satisficing

March again: “Pure rationality strains credulity as a description of how decisions actually happen.” (5) Numerous modifications to the basic model tend to soften one (rarely more than) assumption or another. Most modifications start by relaxing the assumption of perfect knowledge. Still, as predictive theories, such attempts fall well short of empirical scrutiny. In the late 1940’s, Herbert Simon offered his theory of decision-making that has proved the most durable modification of the rational choice model.

The basic premise of Simon's model is that decision makers search only for such information and examine only such alternatives and employ only such decision criteria to produce a result that is "good enough" in some behavioural (or emotional) sense. Limited (or bounded) rationality (commonly referred to as "satisficing") explicitly attempts to model the costs of deciding. It recognizes that, in human terms, memory and comprehension are limited. Communication is not seamless. An important implication from this model is the use of templates and heuristics as means of re-using previously discovered or developed information. Decision makers explicitly or implicitly "match" conditions they face with those they faced before, or at least been made aware of. This can lead to reasoning-by-analogy and all the pitfalls of that approach. In a case study of US involvement in Vietnam, Khong demonstrated that the psychology of analogical reasoning makes it difficult, though not impossible, to use historical analogies properly. (Khong, 1992) One of the more crucial limitations of this approach is a pre-disposition towards a decision. The new "facts" of the situation must overcome the hard-wired "facts" of the previous experience.

Bounded rationality as a model of decision-making offers several advantages and disadvantages as a model for collegial decision-making. The advantages are that it explicitly deals with uncertainty and costs of decisions. The disadvantage is that through the use of schemas, it pre-disposes towards decisions and, in a group setting, requires at least some sense of shared understanding of the underlying schema.

3.1.3 OODA

Col John Boyd, USAF (ret.) developed his theory of decision-making based upon his experiences as a fighter pilot during the Korean War. In trying to answer why US pilots achieved such high kill-to-loss ratio over the Chinese pilots, despite flying aircraft that were only marginally superior to the Soviet-made ones the Chinese employed, he argued the US pilots could process what they saw (observations), match that against stored schema (orient), decide, then act on those decisions faster than their opponents. OODA was born. Over the subsequent years, Boyd extended this model to cover all decision-making circumstances.

Boyd's theory has much strength beyond its wide acceptance. Most important is the emphasis on orientation. Classic rational actor models and reasoning by analogy models share the common pitfall of ignoring context. Decision models such as plan-decide-execute or assess-plan-execute also can lead one into that trap. By stressing the need to orient, and especially by closely examining the elements that make up our mental images (experience, cultural traditions and genetic heritage) that provide the basis for our orientation, Boyd makes explicit the contextual underpinnings of those images. The other strength found in his orientation phase is the emphasis on analysis (or deconstruction) then synthesis (or reconstruction). While this might strike some as very Hegelian or Marxian, it presents a useful, structured approach to problem solving. As Martin van Creveld traced over nearly 4,000 years, technology makes warfare a very complex enterprise. (Van Creveld, 1991) Even with the best databases and tools, it is excessively much to expect any single person to grasp it all. Therefore, any technique that allows breaking the massive problem up into simpler ones without losing the interactions and dependencies of the whole is very useful.

While not often seen, Boyd's model includes implicit guidance and control loops as well as explicit feedback loops among every element in his model. This is a strength over simple general systems theory models of input-process-output. First of all, the implicit loops are often as important (perhaps more so) than explicit loops. For example, during the Bosnian crisis that erupted in summer 1995, coalition members often went "back channel" to their defence ministries to protest actions planned by the operational commanders. Second, separating out guidance and control from feedback is important. During the Gulf War planners routinely interacted with the tactical units on capabilities and status issues to ensure those units were not incorrectly tasked. The third benefit is the almost cybernetic quality of Boyd's model through the multiple access points for guidance or feedback. Again, the low level planners in 1991 found talks directly with mission commanders and other aircrews just as enlightening (perhaps more so) than reading official reports from those units. Van Creveld refers to these exchanges, from the commander's point of view, as "directed telescopes" that allow him to burrow right to critical points

without losing the richness of experience that too often gets stripped away as information percolates up the chain. (Van Creveld, 1985) This is a significant issue for supporting knowledge systems.

3.2 Collegial Decision Making Models.

A major limitation shared by the rational choice, bounded rationality, and OODA decision-making models are their unitary actor perspective. Casual observation of the real world, and major studies of critical decisions of history, shows that in most cases, decisions result from group action, not the actions of a single decision maker. This is true even in cases where ostensibly a “single” decision maker appears to make the final choice. Allison’s (1971) classic study of the 1962 Cuban Missile Crisis is a case in point. Before setting out the elements that must be present in a collegial decision-making model, it is worthwhile to examine some of the pathologies—collective miscalculations--that can arise from a group decision.

3.2.1 Groupthink

One of the more famous studies of group decision-making is Janis’s (1982) *Groupthink*. Lack of norms or cohesiveness, manipulation by one or more members (especially by the group leader), panic are all examples of problems Janis found in the social psychological literature relating to group behaviour. Critical were the first two: the more cohesive the group, the more likely the group rejected views seen as nonconforming to the group’s norms. These norms arise from the tendency of groups to evolve ways of preserving friendly intergroup relations. Groupthink, then, is defined as “a mode of thinking that people engage in when they are deeply involved in a cohesive in-group, when the members’ strivings for unanimity override their motivation to realistically appraise alternative courses of action.” (Janis, 1982: 9)

The addition of this mode to any decision-making model has profound implications for the topic of this paper. Most basically, coalition operations are occasions when groups are formed explicitly for issues that require deep involvement, usually some diplomatic crisis where the use of military force is a real possibility. Second, where unanimity is rarely explicitly required, the very nature of a coalition—ad hoc, specific issue oriented—causes unanimity to become the *de facto* guiding principle. The fragility-cohesiveness spectrum becomes the overriding motivation. Nevertheless, what is missing from Janis’s definition, and the focus of this paper, is the shared representation that underlies the group. It is the “strategic culture” (Gray, 1996: 84) each brings, whether individual or nation, to the table.

3.2.2 Collegial models

We are now in position to describe the key elements required for a collegial decision-making model. First, to reiterate, the use of “collegial” represents the idea that the group shares, at a minimum, a goal. There indeed may be many goals; but lacking at least one, this model is useless. Second, the model must take into account the decision-making process whether described as “plan, execute, assess” or “decide, detect, deliver, assess” or “OODA.” This paper uses OODA to describe the decision-making process and reserves “plan, execute, assess” for the functions the decision-making process is undertaking.

Most importantly, any decision-making model must incorporate and describe the belief structures and models of causality that reside, explicitly or not, within each member of the group. As described more fully in the next section, it is the points of tangency between group members in these areas that will constitute the “degree of shared-ness” of the group. This “shared-ness” can be thin, thick or mediated. There will be no attempt made to provide precise bounds on those categories. However, there are some guidelines available. Lacking any point of tangency in one of the two areas—belief structure or models of causality—constitutes at best a thin degree of sharing. The presence of intervening structures or processes automatically makes the sharing mediated since there is at least one other level of bargaining that must be accounted for. Observationally, coalition members are more likely to have mediated shared awareness than the other two types simply because most coalitions of interest to this paper are ones consisting largely of military forces of state actors. Finally, these points of tangency can exist “vertically” along an axis consisting of numerous groups. In NATO, for example, it could stretch from the Military Committee all the way down to individual flights within a package. For simplicity, this paper considers a “generic” group called “leadership.”

4 Section 4 A Collegial Decision-making Model

Any description of leadership requires pointing out two crucial capabilities. One, it must be aware of its circumstances or situation and secondly, it must make decisions. The actions that result from those decisions are evidence of the behaviours of the decision maker. Hence, the friendly commander seeks to understand in order to influence those actions as the means of attaining the established desired effect.

4.1 Situation Awareness

Situation Awareness (SA) is defined as the perception of the elements in the environment within a volume of time and space, the completeness of their meaning, and the projection of their status in the near future. (Endsley and Jones, 1997: 17) The definition postulates three levels. Level 1 consists of perceptions. Level 2 consists of comprehension and Level 3 consists of projection. Levels 2 and 3 are crucial to decision-making. They provide knowledge and understanding of the environment to the decision makers through a cognitive hierarchy. Endsley and Jones make use of Boyd's Observe-Orientation-Decide-Act (OODA) model and note that SA applies mainly to the Observe and Orient phases. (Ibid. 19-20)

An important consideration in the use of SA is the role played by models and schemata as a means of recognition priming during the Orient phase. These "provide guidance on the critical features of the environment that should be attended to and for the integration and comprehension of that information and the projection of future states, either directly or through related situation prototypes." (Ibid. 24) The models allow for decision making under conditions of incomplete or uncertain information. They provide default information. This is important since the manipulation of an adversary's risk can be a useful means of attaining changes in behaviour. For this note, we assume uncertainty equals risk to a commander. This may not always be so. Another view is that risk for a decision is where each option in the set of possible outcomes has a known probability. Uncertainty is where those probabilities are not known. (Kimminau, 1998: 22, fn 6)

These schemata can also be a source of vulnerability if the information being fed into these mental models is inconsistent with reality leading to incorrect decisions. This mis-orientation is an important element in Boyd's OODA model. This mis-orientation need not be the result of mis-information. It may be beneficial to provide accurate, but unexpected information. This could lead to cognitive dissonance. This plays upon the tendency for individuals to seek consistency between attitudes and behaviours. (Festinger, 1957) When forced to choose between incompatible beliefs or actions, dissonance occurs.

4.2 Framing

Recognition priming (RP) is a means of framing context for decision-making. The importance of framing is the key insight of prospect theory and distinguishes it from the classic rational actor model (RAM) of decision-making. An important consideration must be addressed. Prospect theory presents a richer view of decision makers and hence relies upon much more information about them than a RAM approach. Therefore, if such information is not likely to be available, an EBO approach that utilizes prospect theory is unlikely to succeed. Regardless of the approach employed, this "enhanced information content requirement" has important impact on knowledge systems that support planning, execution, and assessment activities.

Information about the adversary's decision-making apparatus comes from two sources, both related to the four-stage Intelligence Preparation of the Battlespace process. The first is the centre-of-gravity (COG) and target systems analysis (TSA) done during the third stage. Several models are available. The ones in the EBO CONOPS (McCrabb, 2002) derive from those developed by Warden and Barlow. Regardless of the model used, the important information derived is an understanding of the elements from which the adversary derives freedom of action, physical strength, or the will to fight. (HQ USAF/XO, 1999)

The second source of information comes from stage four of IPB that postulates enemy courses of action (COA). Again, it is an assumption of the SA-RP model presented here that behaviours could be derived from actions. Therefore, by postulating a series of enemy actions, that is, a COA, planners are predicting a set of behaviours. Using a wargame, planners can then play out Blue COA options and Red COA

options in an interactive and iterative game. The goal is not precise estimates but rather general tendencies.

4.3 Model

Figure 4 is the complete model. The following subsections describe each element in some detail. “Complete” may be somewhat misleading. The areas of implementation and feedback are not described in much detail. The focus is on the actors and their interactions. Within the actors, the focus is on belief structures as means of framing (or orienting) and the use of models of causality. The latter are not described at all. The use of this collegial decision making model, for example in an effects-based approach to planning, executing, and assessing a military operation by a coalition, would dictate exactly which causal models would be of interest. It is hoped the examples used will relay that flavour.

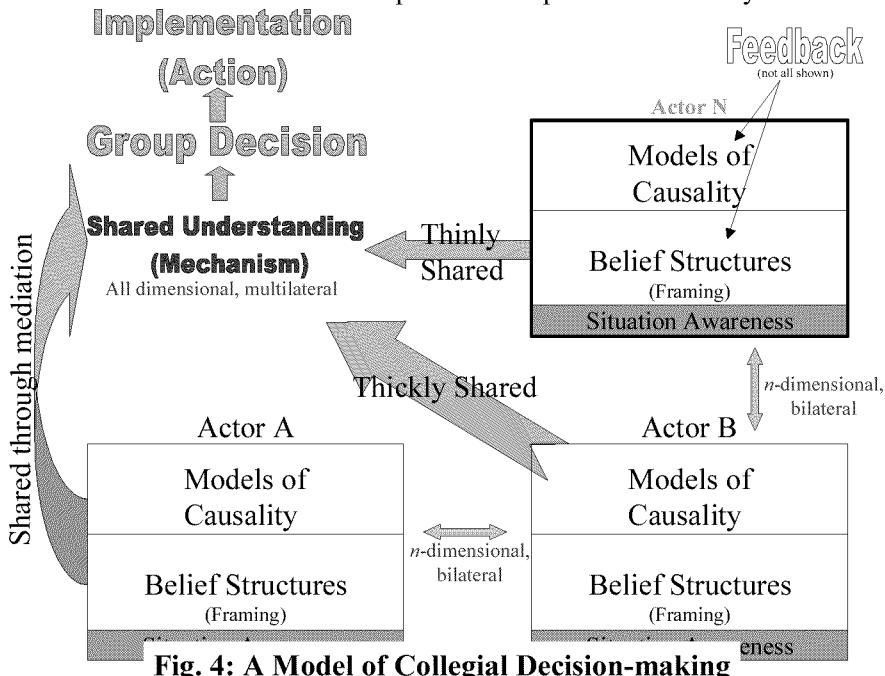


Fig. 4: A Model of Collegial Decision-making

4.3.1 Belief Structures

One way to view the internal schema of an actor is that belief structures constitute the values assigned to individual variables while the causal models constitute the relationships between the variables. However, that would assign much too much a boundary between the two. Concentrating solely on “actor n ” the thickness of the lines around the actor and the relative thinness of the lines between situation awareness, belief structures, and causal models is supposed to relay the fact that internally the lines are much more permeable and translucent than the exterior lines. Beliefs themselves have relationships. This model uses Gray’s notion of “strategic culture.” That is the “socially transmitted habits of mind, traditions, and preferred methods of operation that are more or less specific to a particular geographically based community.” Strategic culture incorporates expressions of strategically adaptive reasoning behaviour. (Gray, 1996: 84)

Preferences and adaptive reasoning are the critical elements in framing. It is how the actor mediates the “raw data” arriving from situation awareness (itself filtered “raw observational data”). Within belief structures, the point of emphasis is on preferences: the set of outcomes, or conditions, the actor prefers to see occurring. It has both the traditional positive element (“prefer to see”) and negative element (“prefer not to see”). An example might be an actor’s preference that an adversary accedes to one’s demands yet without the actor having to cause extensive harm to the adversary. Some argue that is precisely the view NATO wished during Operation ALLIED FORCE, the campaign against Yugoslavia in 1999.

4.3.2 Causal Models

Causal models are used by the actor to make some prediction about how actions that might be taken in the group's name are likely to produce some outcome. By their very nature, causal models are probabilistic. In one sense then, the points of "shared-ness" between actors can be characterized as thick or thin based upon the various probabilities each actor assigns within a given causal model. During ALLIED FORCE, for example, some actors disagreed with the assertion made by the Air Component Commander, USAF Lt General Mike Short, that the best way to stop the Yugoslavians from forcing the Kosovar Albanians from their homes was to bring the war to the folks living in Belgrade. Most of the national representatives adhered to a more traditional view that if the source of the ethnic cleansing was the Yugoslavian military and paramilitary forces within Kosovo, then they were the right targets to attack, not electrical power plants that supplied Belgrade.

Besides showing dependencies, causal models play another important role for group decision-making. They are used to wargame potential course-of-action (COA) the group might develop. By the addition of some thought on what an adversary might do, the group can "play out" the opposing schemes as a way of predicting outcomes. War games can show where an actor's (or the group) situation awareness is lacking hence become a source of investigation. It can also highlight out intervention points, which is where the group, or its agent, might have to intervene in a plan and make adjustments based on the adversary's reactions to the group's COA.

4.3.3 Shared Understanding

Shared data is a necessary but not sufficient condition for shared awareness. Indeed, shared awareness is insufficient to achieve shared understanding. To move from shared data is the role of knowledge systems. The move from awareness to understanding requires much more. It requires understanding the strategic culture of one's coalition partner. As pointed out above, the most important elements in the strategic culture are the predisposition to causal mechanisms, risk proclivity, and belief structures. Techniques for overcoming or mitigating these are beyond the scope of this note. However, wargames, exercises, and other educative activities are the traditional means. These tend to work well for long-standing alliances such as NATO. Whether these techniques would work when faced with the ad hoc nature of "pick up" coalitions such as the one formed to combat global-reach terrorism is more problematic.

4.4 Implications for EBO

Warfare rarely is only about breaking things or killing people. The goal is to affect some sort of change in the opponent's behaviour. Generally that occurs either through brute force means, such as annihilation or attrition, or coercion. In terms of US Joint doctrine, the military aim, at root, is to set the conditions where other instruments of national power—normally political-diplomatic—can take over and attain the strategic aim. War really is politics by another means. To establish these conditions, military commanders must have some understanding of the behavioural effects their actions accomplish. This is true for the operational as well as the strategic levels of war. An isolated battlefield or halted military force has a significant behavioural component.

The challenge for the commander is to trace effects of various actions throughout the enemy to understand what overall affect is taking place. This requires models or knowledge representations that show linkages between physical actions and behavioural effects. Since one of the most important duties of a commander is decision-making, these models must anticipate the decision-making process of the adversary and ideally be adaptable to the decision-making proclivities of our own commanders.

5 Section 5 Implications for Knowledge Systems

5.1 Targeting

5.1.1 COGA

Perhaps the greatest need for knowledge systems lies in the area of targeting. Within that area, the most critical need is to support centre-of-gravity (COG) analysis. Clausewitz wrote "one must keep the dominant characteristics of both belligerents in mind. Out of those characteristics a certain centre of gravity develops, the hub of all power and movement, on which everything depends." (1976 [1832]: 595-

596) He lists five cases: in most it is military forces, it is the capital city where the enemy faces internal strife, the COG is allies and their military forces for small countries, and it is the personalities of the leaders and popular opinion where there is a popular uprising. Early airpower theorists expanded the scope of a COG. US Army Air Service Brigadier General William A. "Billy" Mitchell included "centres of production of all kinds, means of transportation, agricultural areas, ports and shipping; not so much the people themselves." (1988 [1925]: 16) Italian General Giulio Douhet included "industrial and commercial establishments; important buildings, private and public; transportation arteries and centres; and certain designated areas of civilian population as well." (1983 [1921]: 20) In each case, elements—called target systems—combine in unique ways to form COG. Knowledge systems are required to form, and understand, those combinations.

5.1.2 TSA

Joint doctrine defines a target system as "1. All the targets situated in a particular geographic area and functionally related. 2. A group of targets which are so related that their destruction would produce some particular effect desired by the attacker." (JP 1-02) This notion of "relatedness" or system is essential to what is presented here. Instructors at the US Army Air Corps Tactical School (ACTS) in the 1930s emphasized systems analysis to their students. They focused on "major industrial and economic systems for production of weapons and supplies for their armed forces, and for manufacture of products and provision of services to sustain life in a highly industrialized society." (Quoted in Faber, 1997: 217) Most importantly, they focused on the connections and dependencies between and within these systems that formed an "industrial web" where attacks against one element in the web would ripple throughout the web causing more problems than just the immediate damage done. From COG and target systems analysis, course-of-action (COA) options are developed. This is the second great area in which knowledge system support is crucial.

5.2 Strategy and COA Development

A COA is defined as "a *plan* that would accomplish, or is related to, the accomplishment of a mission." It is also defined as "the scheme adopted to accomplish a task or mission." Furthermore, "when approved, the ... [COA] becomes the basis for the development of an operations plan or operations order." (JP 1-02) There are several conceptual definitions closely related to COA. A concept of operations, within the same context and sub-contexts, "describes how the [Joint Force Commander] visualizes the operation will unfold based on the selected COA. This concept expresses *what*, *where*, and *how* the joint force will affect the enemy or the situation at hand." (JP 3-0)

The end state, goal or objective is *what* is to be accomplished, purpose or rationale provides *why* the goal is sought, the plan or sequence of actions is *how* the goal or objective is going to be accomplished, and resources are the wherewithal (or "*with*") for the plan. Specifying *who* will accomplish the actions and *where* and *when* in the sequence completes the COA. Military strategy is defined as the art and science of employing forces to secure objectives by the application of force or the threat of force (adapted from JP 1-02). A campaign, or operational-level, plan is defined as a series (or sequence) of related operations (or actions) aimed at accomplishing an objective within a given space and time (adapted from JP 1-02).

5.3 Wargaming

The third large area in which knowledge systems are needed to support effects-based coalition operations is in wargaming. EBO requires real or near-real time operational level wargaming of Blue versus Red COA. Development is sorely needed to build a robust, computerized operational level wargaming tool. This tool can take Blue COA options such as those generated by the Air Force Research Lab's Strategy Development Tool (SDT) and wargame them against Red COA options generated from some IPB tool or process. Today, COA versus COA wargaming if done at all, is done on paper using situation and event templates. Most computerized wargaming tools such as STORM (Synthetic Theatre Operations Research Model) have a force-on-force, target-attrition emphasis. Though they do support and analyse higher level objectives such as *establish air supremacy*, *defeat warfighting forces*, or *disrupt enemy leadership*; they are not adequate to satisfy EBO wargaming requirements.

Wargaming to support Effects Based Operations has to account for criteria related to both friendly and adversary COAs. Adversary COAs are derived based on the process defined in Joint Publication 2-01.1,

Joint Tactics, Techniques, and Procedures for Joint Intelligence Preparation of the Battlespace. Determination of adversary COA is the last step in a four-step process. This final IPB step includes:

- Identifying the adversary's likely objectives and desired end states,
- Identifying the full set of COA available to the adversary,
- Evaluating and prioritising each COA, and
- Developing each COA in the amount of detail time allows.

The process in JP 2-01.1 needs to be computerized with an explicit focus on EBO. For example, the doctrine prescribes the use of psychological profiling of adversary leaders to determine their acceptable level of risk; but EBO will require broader cognitive modelling and behavioural analysis of not only warfighting decision making commanders, but also of political leadership and the general population. Friendly COA built using AFRL's SDT tightly link commander's intent (objectives) to desired effects. The focus is explicitly on physical and behavioural effects including direct, indirect, cumulative, and cascading effects. Centres of gravity and target analysis are used to identify targetable actions necessary to achieve the effects desired. Existing computerized wargaming tools are limited in that they do not address the interplay of various COA in a simulated environment nor do they appropriately deal with effects. Most of these are highly robust when it comes to engagements (e.g., tanks against tanks or aircraft against armour forces) but are quite thin at the campaign level and of little use in evaluating an operational-level COA. (McCrabb and Caroli, 2002)

6 Section 6 Conclusion

This research note presented some preliminary thoughts on how effects-based operations impacted classic military decision-making and how collegial decision-making, such that characterizes coalitions, places further demands on supporting knowledge systems. This is particularly so in the areas of targeting, where not only first order physical effects but n-order behavioural effects must be traced; course-of-action (COA) development where the many effects intermingle and produce cumulative effects; and wargaming where such plans are “played out” against various evaluative criteria.

Each of these elements influences group decision-making structures. Each actor is immersed in a strategic culture with the key elements of belief structure, causal models, and certain risk proclivities. Targeting and COA development affect the first two; wargames provide one means of at least making explicit the latter.

Collegial decision-making in a military environment is an area ripe for further research. One approach is agent-based modelling where distributed; decentralized decision-making could be examined to see to what degree dynamical structural behavioural outcomes are predictable. Classic chaos theory, with its emphasis on the sensitivity of initial conditions, seems to argue that such behaviours are unlikely to be predictable with any sufficient degree of certainty to overcome a wide range of prudence normally associated with the employment of force. On the other hand, work in complex adaptive systems theory seems to offer the promise of a higher degree of predictability. (Holland, 1995; Alberts, Garstka, and Stein, 1999; Czerwinski, 1998)

References

Alberts, D.S., Garstka, J.J., and Stein, F.P. (1999) “Network Centric Warfare,” US Department of Defence C4ISR Cooperative Research Program, Washington, DC, USA

Allison, G.T. (1971) “Essence of Decision,” Harper Collins, New York, NY, USA

Clausewitz, C. (1832) “On War,” reprint Princeton University Press, Princeton, NJ, USA

Czerwinski, C.J. (1998) “Coping with Bounds,” Institute for National Strategic Studies, National Defence University, Washington, DC, USA

Davis, P.K. (2001) “Effects-based Operations: A Grand Challenge for the Analytical Community,” RAND, Santa Monica, CA, USA

Dixit, A.K. and Nalebuff, B.J. (1991) "Thinking Strategically," W.W. Norton, New York, NY, USA

Douhet, G. (1921) "Command of the Air," reprint Office of Air Force History, Washington, DC, USA

Endersley, M. and Jones, W.M. (1997) "Situation Awareness Information Dominance and Information Warfare," Air Force Research Laboratory, Wright-Patterson AFB, OH, USA

Faber, P.R. (1997) "Interwar US Army Aviation and the Air Corps Tactical School: Incubators of American Airpower," The Paths of Heaven: The Evolution of Airpower Theory, Air University Press, Maxwell AFB, AL, USA

Festinger, L. (1957) "A Theory of Cognitive Dissonance," Stanford University Press, Stanford, CA, USA

Gray, C.S. (1996) "Explorations in Strategy," Greenwood Press, Westport, CT, USA

HQ USAF/XO (1999) "Intelligence Preparation of the Battlespace: An Airmen's Introduction," White Paper, February 1999

Holland, J.H. (1995) "Hidden Order," Perseus, Reading, MA, USA

Janis, I.L. (1982) "Groupthink," Houghton Mifflin, Boston, MA, USA

Joint Pub 1-02 (2001) "Dictionary of Military and Associated Terms," US Department of Defence, Washington, DC, USA

Joint Pub 2-01.3 (2000) "Joint Tactics, Techniques, and Procedures for Joint Intelligence Preparation of the Battlespace," US Department of Defence, Washington, DC, USA

Joint Pub 3-0 (2001) "Doctrine for Joint Operations," US Department of Defence, Washington, DC, USA

Khong, Y.F. (1992) "Analogies at War," Princeton University Press, Princeton, NJ, USA

Kimminau, J.A. (1998) "The Psychology of Coercion: Merging Airpower and Prospect Theory, Maxwell AFB, AL: School of Advanced Airpower Studies

March, J.G. (1994) "A Primer on Decision Making," Free Press, New York, NY, USA

McCrabb, M.J. (2001) "Explaining Effects," Air Force Research Laboratory, Rome, NY, USA

McCrabb, M.J. (2002) "Concept of Operations for Effects-based Operations," Aerospace Command, Control and Intelligence, Surveillance, and Reconnaissance Centre, Langley AFB, VA, USA

McCrabb, M.J. and Caroli, J.A. (2002) "Behavioral Modeling and Wargaming for Effects-Based Operations," Military Operations Research Society, Washington, DC, USA

Mitchell, W. (1925) "Winged Defence," reprint Dover Publishing, New York, NY, USA

Van Creveld, M. (1985) "Command in War," Harvard University Press, Cambridge, MA, USA

Van Creveld, M. (1991) "Technology in War" Harvard University Press, Cambridge, MA, USA